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IN RE APPLICATION OF: Nicolas VOYER | GAU: 2681

SERIAL NO: 10/724,212 | EXAMINER:

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FOR: METHOD OF SIMULATING OPERATING CONDITIONS OF A TELECOMMUNICATION SYSTEM REQUIRING A LIMITED AMOUNT OF COMPUTING POWER

REQUEST FOR PRIORITY

COMMISSIONER FOR PATENTS
ALEXANDRIA, VIRGINIA 22313

SIR:

☐ Full benefit of the filing date of U.S. Application Serial Number , filed , is claimed pursuant to the provisions of **35 U.S.C. §120**.

☐ Full benefit of the filing date(s) of U.S. Provisional Application(s) is claimed pursuant to the provisions of **35 U.S.C. §119(e)**: **Application No.** **Date Filed**

■ Applicants claim any right to priority from any earlier filed applications to which they may be entitled pursuant to the provisions of **35 U.S.C. §119**, as noted below.

In the matter of the above-identified application for patent, notice is hereby given that the applicants claim as priority:

COUNTRY	**APPLICATION NUMBER**	**MONTH/DAY/YEAR**
EUROPEAN PATENT OFFICE	02292964.0	December 2, 2002

Certified copies of the corresponding Convention Application(s)

- ■ are submitted herewith
- ☐ will be submitted prior to payment of the Final Fee
- ☐ were filed in prior application Serial No. filed
- ☐ were submitted to the International Bureau in PCT Application Number
  Receipt of the certified copies by the International Bureau in a timely manner under PCT Rule 17.1(a) has been acknowledged as evidenced by the attached PCT/IB/304.
- ☐ (A) Application Serial No.(s) were filed in prior application Serial No. filed ; and
- ☐ (B) Application Serial No.(s)
  - ☐ are submitted herewith
  - ☐ will be submitted prior to payment of the Final Fee

Respectfully Submitted,

OBLON, SPIVAK, McCLELLAND,
MAIER & NEUSTADT, P.C.

Joseph A. Scafetta Jr.

Marvin J. Spivak
Registration No. 24,913

Joseph A. Scafetta, Jr.
Registration No. 26, 803

Customer Number
22850
Tel. (703) 413-3000
Fax. (703) 413-2220
(OSMMN 05/03)

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Bescheinigung

Certificate

Attestation

Die angehefteten Unterlagen stimmen mit der ursprünglich eingereichten Fassung der auf dem nächsten Blatt bezeichneten europäischen Patentanmeldung überein.

The attached documents are exact copies of the European patent application described on the following page, as originally filed.

Les documents fixés à cette attestation sont conformes à la version initialement déposée de la demande de brevet européen spécifiée à la page suivante.

Patentanmeldung Nr. **Patent application No.** **Demande de brevet n°**

02292964.0

Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
p.o.

R C van Dijk

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Anmelder/Applicant(s)/Demandeur(s):

Mitsubishi Electric Information Technology
Centre Europe B.V.
Capronilaan 46
1119 NS Schiphol Rijk
PAYS-BAS
MITSUBISHI DENKI KABUSHIKI KAISHA
2-3, Marunouchi 2-chome,
Chiyoda-ku
Tokyo 100-8310
JAPON

Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.
If no title is shown please refer to the description.
Si aucun titre n'est indiqué se referer à la description.)

Method of simulating operating conditions of a telecommunication system requiring a limited amount of computing power

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The present invention relates to a method of simulating operating conditions of a telecommunication system including a plurality of radio base stations and another plurality of mobile transceivers.

Such methods are currently used for optimizing, before actual physical implementation of a telecommunication system, a deployment of radio base stations forming a network included in said system, on the one hand, and a design of a decision-making network infrastructure which is intended to manage said network, on the other hand, in order to define a telecommunication system able to provide optimal communication service at the lowest possible cost.

Some simulation methods, known as mapping methods and currently used for optimizing GSM-type telecommunication systems, which systems are often referred to as 2G (standing for second generation) systems, generate best-server maps showing geographical coverage areas, each area forming a cell including a single base station, which map enables to assess the coverage of the system, following the general principle that if a mobile transceiver is located within a cell and if the associated base station is not saturated, said mobile transceiver will be provided with a satisfactory communication service.

An assessment of quality of service in UMTS-type telecommunication systems, often referred to as 3G (standing for third generation) systems, cannot be accurately obtained by means of a method as described above, mainly because 3G systems do not perform a frequency planning as is done in 2G systems, where to two different mobile transceivers located in a same geographical area are allocated two different communication frequencies, so as to minimize interference between said mobile transceivers. In 3G systems, no such frequency planning is performed, so that communication interference between mobile transceivers can and will occur, which will adversely affect the quality of each ongoing communication to an extent which varies from one mobile transceiver to another according to the specific situation of each mobile transceiver, which extent cannot be predicted by means of the above-mentioned described methods.

Another known simulation method, usually referred to as Monte-Carlo method, mainly consists in generating a plurality of snapshots, each being descriptive of a predetermined, random-generated situation of the system. Each snapshot then shows the location of all mobile transceivers of the system in the corresponding situation, the base stations with which said mobile transceivers are communicating, and a level of power each mobile transceiver is applying to its ongoing communication, which enables to deduce the amount of interference said mobile transceiver generates for other mobile transceivers located in his vincinity, and thus the extent to which interference generated by other mobile transceivers adversely affects each single mobile transceiver in each random-generated situation. The operation of such a method is described, among others, in an introducing part of European Patent Application EP 1 148 658 A1.

The Monte-Carlo method hence enables to establish, for each random-generated situation, the number of mobile transceivers to which a satisfactory communication service is provided, and enables statistical assessment of the overall communication quality offered by the simulated system.

The amount of interference affecting each communication between a given mobile transceiver and an associated radio base station is represented by a value of an interference parameter, for example a signal-to-noise ratio, which is computed, in the known art, by means of complex formulae which take into account all other communications simultaneously going on in the whole simulated telecommunication system, because of the lack of frequency planning in 3G systems.

Such formulae can for example be expressed as follows :

For each mobile transceiver MSi, a signal-to-noise ratio $SINR_{i,j}$ representing the amount of interference affecting a communication involving said mobile transceiver MSi and generated by communications going on in a cell Cellj including a radio base station BSj is given by:

$$SINR_{i,j} = \frac{P_{Ti,j}.G_{i,j}}{N_0 + \sum_{l \neq j} \sum_{k \in Cellj} P_{Tk,j}.G_{i,l} + \alpha_{MS}.\beta.\sum_{k \in Cellj} P_{Tk,j}.G_{i,j}},$$

where $P_{Ti,j}$ represents an amount of power transmitted by the radio base station BSj to

the mobile transceiver MSi, $G_{i,j}$ represents a coupling loss between the mobile transceiver MSi and the radio base station BSj., N_0 represents a predermined noise value, α_{MS} represents an interference removal factor and β represents a channel orthogonality factor.

The overall signal-to-noise ratio $SINR_i$ representing the amount of interference affecting said communication involving said mobile transceiver MSi and generated by all communications going on in all other cells of the telecommunication system is then given by:

$$SINR_i = \sum_{All j} SINR_{i,j}.$$

It is easily understood that a computation of interference parameters such as the signal-to-noise ratios described above will require huge amounts of computing power, since the 3G telecommunication systems to be realistically simulated will typically involve thousands of radio base stations and hundred of thousands of mobile transceivers. Moreover, all values involved in such a computating step, like coupling loss values $G_{i,j}$ and transmitted power values $P_{Ti,j}$, have to be stored in memory means and read in due course of the execution of the computing step, which, again because of the enormous quantity of those values, will require huge memory space and processing power for performing all necessary read/write operations.

The present invention aims at solving the above-mentioned problems, by providing a method of simulating operating conditions of a telecommunication system, which method requires less computing power and less memory space than currently used methods.

To this end, according to one of its software-oriented aspects, the invention provides a method of simulating operating conditions of a telecommunication system including a plurality of radio base stations and another plurality of mobile transceivers, said method including a computing step for computing at least one value of at least one interference parameter related to one of said mobile transceivers, which interference parameter is indicative of an amount of interference affecting a communication between said mobile transceiver and an associated radio base station,

said method including:

. an identification step for identifying radio base stations and mobile transceivers which will generate significant amounts of interference affecting said communication, and

. a selection step for selecting data related only to those radio base stations and mobile transceivers identified during the identification step for execution of the computing step.

The invention enables to select only a small part of the data which is used in known methods for computing the interference parameter. This in turn enables to use less memory space for storing the selected data and less computing power for processing said data in the course of the execution of the computing step.

It should be noted that the radio base stations identified during the identification step are recognized as stations which produce significant effects, not as those stations which produce the most significant effects. Such a subtle difference, which underlies the basic operating principle of the invention, enables to dispense with a ranking of all cells which would again require huge memory space for storing all values to be compared together in order to establish said ranking, and huge amounts of computing power for actually comparing all these values.

The degree of significance may be expressed by choosing at least one specific criterion, which should preferably be decorelated with respect to the above-mentioned data.

In a specific embodiment of the invention, a method as described hereinbefore further includes a list generation step for creating, for each given cell including a radio base station, a neighbour list containing identities of neighbour cells including radio base stations with which a mobile transceiver included in said given cell could potentially establish a communication, the identification step then essentially consisting in identifying neighbour cells of a cell including the mobile transceiver to which the interference parameter to be computed relates.

The neighbour list may simply be constituted of a monitored set of cells generated by a radio network controller and broadcasted to all mobile transceivers included in each given cell, each mobile transceiver then being intended to monitor

the strength of pilot signals coming from each cell included in said monitored set, as set forth in a 3GPP TS 25.331 standard specification.

The neighbour list may also be constituted of cells having a coverage area geographically adjacent to that of the given cell, such cells then being neighbours of the given cell in a litteral sense.

In any case, according to this specific embodiment of the invention, all data not pertaining to cells included in the neighbour list of the given cell including the mobile transceiver to which the interference parameter to be computed relates will be discarded.

In another specific embodiment of the invention, the identification step essentially consists in identifying cells which are neighbours to a predermined degree of the cell including the mobile transceiver to which the interference parameter to be computed relates.

This other specific embodiment enables to perform, in a simple and user-friendly manner, a compression of the data to be used in the course of the computing step. An operator of a simulation device in which a method according to this specific embodiment of the invention is used will only have to enter a degree N of neighbourship for tuning the accuracy of the computation performed during the computing step.

If said operator chooses N=1, only data pertaining to cells which are neighbours to the first degree of the given cell including the mobile transceiver to which the computed interference parameter will be selected, i.e. data pertaining to each cell which is listed on the neighbour list related to said given cell, as in the previously described specific embodiment.

If said operator chooses N=2, data pertaining to cells which are neighbours to the first degree of the given cell including the mobile transceiver to which the computed interference parameter will be selected, but also data pertaining to cells which are neighbours to the second degree of said given cell, or, to put it differently, data pertaining to neighbours of neighbours of the given cell. The choice of N=2 thus enables to add to the data taken into account by choosing N=1 data pertaining to each

cell which is listed on each neighbour list related to each cell which is listed on the neighbour list of said given cell.

It will be easily understood that higher values of the neighbourship degree N enable to obtain more accurate values for the interference parameter, but involve more processing power and memory space for computing said values.

Conversely, the more distant a cell is in a neighbourship hierarchy related to the the cell including the mobile transceiver for which the interference parameter is to be computed, the less significant data pertaining to this distant cell will be.

As stated above, the neighbour list of a given cell may be generated on the basis of the monitored set of said cell or by selecting cells whose coverage areas are adjacent to that of said given cell.

According to one of its hardware-oriented aspects, the invention also relates to a simulation device for simulating operating conditions of a telecommunication system including a plurality of radio base stations and another plurality of mobile transceivers, said device including computing means for computing at least one value of an interference parameter related to at least one of said mobile transceivers, which interference parameter is indicative of an amount of interference affecting a communication between said mobile transceiver and an associated radio base station, said device further including:

. identification means for identifying those radio base stations and mobile transceivers which will generate significant amounts of interference affecting said communication, and

. selection means for selecting data related only to those radio base stations and mobile transceivers identified by the identification means for transmission to the computing means.

According to another one of its hardware-oriented aspects, the invention also relates to a simulation device as described above, which further includes list generation means for creating, for each given cell including a radio base station, a neighbour list containing identities of neighbour cells including radio base stations with which a mobile transceiver included in said given cell could potentially establish

a communication, the identification means then being essentially intended to identify neighbour cells of a cell including the mobile transceiver to which the interference parameter to be computed relates.

According to a specific embodiment of the hardware-oriented aspect described above, the identification means are essentially intended to identify cells which are neighbours to a predermined degree of the cell including the mobile transceiver to which the interference parameter to be computed relates.

According to another one of its hardware-oriented aspects, the invention also relates to a simulation device comprising :

. a simulation module intended to simulate movements and ongoing communications of said mobile transceivers according to a given set of operating conditions of the radio base stations and transceivers, said simulation module including the computing means, the identification and the selection means, and

. a management module intended to update said given set of operating conditions of the radio base stations and transceivers with respect to said simulated movements and ongoing communications of said mobile transceivers, said management module including the list generation means,

in which the simulation and management modules operate asynchronously with respect to each other.

The feature according to which the simulation module simulates the actual behaviour of mobile transceivers, like the movements and ongoing communications thereof, enables to reduce the number of generated situations to those who are consistent with each other and thus realistic, which in turn enables to reduce the amount of computing power required for operating the simulation device according to the invention.

The further feature according to which the simulation and management modules operate asynchronously with respect to each other enables to simulate the inertia linked to the decision process involved in the management of the telecommunication system.

According to one of its user-oriented aspects, the invention also relates to the use of a simulation device as described hereinbefore for testing a radio network controlling unit intended to manage ongoing communications between mobile transceivers and radio base stations in an actual deployment of a telecommunication system, said use essentially consisting in substituting said radio network controlling unit for the management module.

This aspect of the invention enables testing of a manufactured radio network controller, which will have been designed and built for the purpose of managing a telecommunication system whose behaviour will be realistically simulated by virtue of the invention. The invention thus enables to validate such a design without requiring to actually build the whole telecommunication system to this aim. This user-oriented aspect of the invention likewise allows to test decision-making algorithms included in a management module which would be provided by an operator of the simulation device and be substituted for the internal management module described above.

According to another of its user-oriented aspects, the invention also relates to the use of a simulation device as described hereinbefore for testing a radio base station intended to be included in the simulated telecommunication system when actually deployed, said use essentially consisting in connecting said radio base station to the simulation module.

The invention thus enables to validate the design of a radio base station before its actual deployment in the field.

The characteristics of the invention mentioned above, as well as others, will emerge more clearly from a reading of the following description given in relation to the accompanying figures, amongst which:

Fig.1 is a functionnal diagram which depicts a simulation device using a method according to the invention,

Fig.2 is a flowchart, which depicts successive steps to be executed in a method according to the invention,

Fig.3 is a functional diagram which depicts a possible use of a simulation device according to the invention, and

Fig.4 is a schematic which represents a simplified best-server map to be used in the course of the execution of a list generation step included in a method according to the invention.

Fig.1 diagrammatically shows a simulation device SD intended to simulate operating conditions of a telecommunication system, in which a method according to the invention is used. This device SD includes a first database GD, intended to store geographical data pertaining to a landscape over wich the telecommunication system is intended to be deployed, for example models of obstacles like buildings, mountains, etc. The simulation device SD further includes a second database BSD, intended to store data pertaining to radio base stations forming a network included in the system, like a geographical location of each base station, a maximum number of communications each base station is able to handle at a given instant, or a maximum transmitting power each base station is able to apply to its ongoing communications, etc. The simulation device SD also includes a third database UED, for example intended to store or generate a collection of files, each file being associated with a mobile transceiver which will appear in the course of the simulation, and containing, listed in chronological order, successive coordinates, speeds, transmission powers or data rates to be attributed to ongoing communications between each mobile transceiver and a base station. The first and second databases GD and BSD thus contain data of a structural nature, representative of the deployement of the radio network included in the system and of geographical constraints said network will operate under, whereas the third database UED contains dynamic data, representative of events which will happen during the operation of the system.

In this embodiment of the invention, the first, second and third databases GD, BSD and UED are intended to be loaded by an operator of the simulation device SD by means of a loading interface LDINT.

The simulation device SD includes a simulation module SIMM intended to process data provided by the above mentioned first, second and third databases GD, BSD and UED by means of respective data signals Dg, Dbs and Due. The simulation module SIMM will generate successive snapshots of the system, by fetching for each

snapshot a set of data from the first, second and third databases GD, BSD and UED, and performing a synthesis of said data by determining, among others, the amount of power applied by each mobile transceiver to its ongoing communication and/or the amount of interference generated by each mobile transceiver and its adverse effects on communications of other mobile transceivers. The third database UED may be arranged so as to provide, among other correlating parameters, instantaneous values of specified datarates for the various communications supported by the system at the corresponding instants, in which case the simulation module SIMM will determine an amount of power which must be applied to each mobile transceiver's ongoing communication for ensuring that the corresponding specified datarate is respected, and an interference level linked to this amount of power. In another possible embodiment, the third database EUD will provide a value of the power to be applied to each ongoing communication, and the simulation module SIMM will only have to determine, for each snapshot, the amount of interference generated by said ongoing communications.

The simulation module SIMM includes for such purposes computing means CMPM for computing values of interference parameters related to individual mobile transceivers, each interference parameter, e.g. a power-to-interference or a signal-to-noise ratio, being indicative of an amount of interference affecting a communication between a given mobile transceiver and an associated radio base station

At the end of each snapshot-generating process, the simulation module SIMM delivers, via a management module which will be described in more detail hereinafter, a set of output data signals Dout representative of the results of the above-described synthesis to a register REG for storage pruposes, which register REG is linked to a display interface DISP intended to deliver results of the simulation to the operator of the simulation device SD. The display interface DISP may be provided with means for interpreting the output data Ds, which could enable said display interface DISP to extract from said output data Ds values of a parameter representative of communication quality, like a power-to-interference or a signal-to-noise ratio, to be

attributed to each mobile transceiver, and for displaying such values, for example in varying colours or brightnesses on a map depicting the telecommunication system.

The invention thus enables to provide an operator of the simulation device SD with a historical view of the operating conditions of the simulated system, and hence to follow the evolution over time of individual communications, from their beginnings to their conclusions, which in turn enables to assess the quality of the service provided to individual mobile transceivers.

In this embodiment of the invention, the simulation device SD includes, in addition to the simulation module SIMM intended to simulate movements and ongoing communications of the mobile transceivers according to a given set of operating conditions of the radio base stations and transceivers, a management module MNGM intended to update said given set of operating conditions of the radio base stations and transceivers with respect to said simulated movements and ongoing communications of said mobile transceivers, said management module MNGM being intended, among other tasks, to determine for each snapshot which mobile transceiver should be in communication with which radio base station.

In this embodiment of the invention, the simulation and management modules SIMM and MNGM operate asynchronously with respect to each other, which enables to simulate the inertia induced by the decision-taking process involved in an updating of the current set of operating conditions of the radio base stations and transceivers performed by the management module MNGM on the basis of stimuli provided by the simulation module SIMM.

Such stimuli are intended to be transmitted by the simulation module SIMM via a data exchange path DXP after said simulation module SIMM will have required an interruption, through an interruption path INT, of the operation of the management module MNGM. Such a solution enables each of the simulation and management modules SIMM and MNGM to operate independently with respect to each other while allowing data exchange between said modules.

More specifically, the management module MNGM includes list generation means for creating, for each given cell including a radio base station BSj, a neighbour

list NBL(BSj) containing identities of neighbour cells including radio base stations with which a mobile transceiver included in said given cell could successfully establish a communication. The neighbour list NBL(BSj) of a given cell may for example be generated on the basis of the monitored set of said cell or by selecting cells whose coverage areas are adjacent to that of said given cell.

The management module MNGM is intended to provide the simulation module SIMM with these neighbour lists NBL(BSj) via the data exchange path DXP according to the process described above.

In this specific embodiment of the simulation device SD, the simulation module SIMM includes:

. scenario generating means SGEN for computing the position of each mobile transceiver according to a predefined trajectory said mobile transceiver is intented to follow,

. transceiver simulation means UESM for emulating signals transmitted or received by each of said mobile transceivers, and including the computing means CMPM intended to compute an amount of power exhibited by signals transmitted by each mobile transceiver, as well as an amount of interference affecting said signals, and

. base station simulation means BSSM for emulating signals transmitted or received by each radio base station and radio links between said radio base stations and transceivers, and computing an amount of power exhibited by signals transmitted by each radio base station.

The base station simulation means BSSM will usually operate on the basis of data Dbs provided by the second database BSD, which contains models of the various radio base stations whose deployment is to be simulated. In the example described here, however, the base station simulation means BSSM are also connected to a real radio base station BSK with which they exchange data DSk in order to test the real behaviour of this radio base station BSK when confronted with stimuli which emulate those it will encounter during its actual deployment. This allows to validate the design

of a radio base station without actually building an entire telecommunication system to this aim.

On the basis of data signals Dg and Due provided by the first and third databases GD and UED, the scenario generating means SGEN compute, for each snapshot, the position of each mobile transceiver with respect to all other transceivers, and the amount of power involved in all ongoing communications, which will among others enable the transceiver simulation means UESM to determine the amount of interference caused by all ongoing communications to each individual ongoing communication.

In order to limit the processing power and memory space required for this purpose, the transceiver simulation means UESM further include :

. identification means IDM for identifying those radio base stations and mobile transceivers which will generate significant amounts of interference affecting said communication, and

. selection means SM for selecting data related only to those radio base stations and mobile transceivers identified by the identification means for transmission to the computing means.

In this specific embodiment of the invention, the identification means IDM are essentially intended to identify cells which are neighbours to a predermined degree N of the cell including the mobile transceiver to which the interference parameter to be computed relates, the value of said degree N having been previously loaded by an operator of the simulation device SD through the loading interface LDINT.

This specific embodiment enables to perform, in a simple and user-friendly manner, a compression of the data to be used by the computing means CMPM. An operator of the simulation device SD will only have to modify the value of the degree of neighbourship N for tuning the accuracy of the computation performed by the computing means.

If said operator chooses N=1, only data pertaining to cells which are neighbours to the first degree of the given cell including the mobile transceiver to which the computed interference parameter will be selected, i.e. data pertaining to each cell

which is listed on the neighbour list related to said given cell, as in the previously described specific embodiment.

If said operator chooses N=2, data pertaining to cells which are neighbours to the first degree of the given cell including the mobile transceiver to which the computed interference parameter will be selected, but also data pertaining to cells which are neighbours to the second degree of said given cell, or, to put it differently, data pertaining to neighbours of neighbours of the given cell. The choice of N=2 thus enables to add to the data taken into account by choosing N=1 data pertaining to each cell which is listed on each neighbour list related to each cell which is listed on the neighbour list of said given cell.

Higher values of the neighbourship degree N hence will enable to obtain more accurate values for the interference parameter, but will involve more processing power and memory space for computing said more accurate values.

Fig.2 is a flow chart showing a method of simulating operating conditions of a telecommunication system including a plurality of radio base stations and another plurality of mobile transceivers, said method including a computing step CMP(IPi, Dj) for computing at least one value of at least one interference parameter related to one of said mobile transceivers, which interference parameter is indicative of an amount of interference affecting a communication between said mobile transceiver and an associated radio base station,

said method including:

. an identification step IDS(SCj) for identifying cells SCj including radio base stations BSj and mobile transceivers which will generate significant amounts of interference affecting said communication, and

. a selection step SEL(Dj) for selecting data Dj related only to those cells SCj identified during the identification step IDS(SCj) for execution of the computing step CMP(IPi, Dj).

The method described in this example also includes a list generation step LGS for creating, for each given cell including a radio base station BSj, a neighbour list MBL(BSj) containing identities of neighbour cells including radio base stations with

which a mobile transceiver included in said given cell could successfully establish a communication. The neighbour list NBL(BSj) of a given cell may be generated on the basis of the monitored set of said cell or by selecting cells whose coverage areas are adjacent to that of said given cell.

The identification step IDS(SCj) essentially consists here in identifying cells SCj which are neighbours to a predermined degree N of the cell including the mobile transceiver to which the interference parameter to be computed relates, which enables to tune, in a simple and user-friendly manner, a ratio of compression of the data to be used during the computing step CMP(IPi, Dj), by adjusting the value of the degree of neighbourship N. Such a compression enables to reduce the amount of processing power and memory space required for executing the computing step CMP(IPi, Dj), which will be all the more advantageous if various values of a plurality of interference parameters related to a plurality of mobile transceivers are to be computed, since the above described compression will affect all data which are to be used in the course of such a computation.

Fig.3 depicts a possible use of the simulating device SD according to the invention, which enables to validate the design of an external radio network controller RNC. Such a controller is intended to manage the operation of a 3G system when actually deployed. A radio network controller RNC is usually build by telecommunication system manufacturers according to internal proprietary specifications which are unknown to the tester, but are intended to communicate with a 3G telecommunication network by means of messages whose format is set by the 3GPP standard specification. The simulation device SD thus includes an interruption interface II allowing to translate messages sent by the simulation module SIMM via the interruption path INT into the suitable format specified by said 3GPP standard in order for these messages to be intelligible for the radio metwork controller RNC. The simulation device SD further includes a data interface DI allowing to translate messages sent via the data exchange path DXP to/from the simulation module SIMM by/to the radio metwork controller RNC. Thanks to these interfaces, the radio network controller RNC may be arranged to simply shunt the management module MNGM

and be substituted for it. The invention then enables to easily and realistically simulate the behaviour of such a radio network controller RNC, without requiring to actually build an entire telecommunication system to this aim.

In a similar mobile user-oriented aspect of the invention, the simulation device may be used for testing decision-making algorithms included in an external management module which would be provided by an operator of the simulation device SD and be substituted for the radio network controller RNC, and thus also for the internal management module MNGM.

Fig.4 is a very schematic diagram which represents a best-server map BSMP of a 3G telecommunication system, which map has been generated by executing a mapping step in the course of a neighbour list generating step. This best-server map BSMP exhibits coverage areas AC1...AC16 of cells including radio base stations BS1...BS16, which means that in the coverage area ACk of a given cell, the radio base station BSk included in said cell will offer the best possible communication quality to a mobile transceiver located within said coverage area ACk. This communication quality may be assessed by analysing parameters such as Coupling Loss (CL) values, Received Signal Code Power (RSCP), Common Pilot CHannel (CPCH) strength, Energy Chip/Noise (EC/NO), etc.

In this example, a particular cell including a radio base station BS4 is singled out as exhibiting a coverage area composed of three separate coverage areas AC41, AC42 and AC 43. This may sometimes happen due to landscape features which may cause a given coverage area, like in this example areas AC2, AC5 or AC7, to include one or several pockets where a base station like base station BS4, which is not the base station nominally associated with said given area, in this example base stations BS2, BS5 or BS7, will provide the best service to a mobile transceiver located within such a pocket.

In the situation depicted here, a communication is established between a mobile transceiver MSi and the radio base station BS4 through a radio link LNK. This communication will feature a quality which will be adversely affected by communications going on in the same or other cells, which quality, or loss thereof,

may be quantified by using an interference parameter like a signal-to-noise or a power-to-interference ratio. While all other communications simultaneously existing in the telecommunication system are taken into account in known simulating methods, the method according to a preferred embodiment of the invention enables to reduce the amount of data to be processed by identifying, and selecting as significant, only data pertaining to cells which are neighbours to a predermined degree of the cell including the mobile transceiver to which the interference parameter to be computed relates.

Neighbour lists are thus generated for each cell, so that if a neighbourship degree equal to N has been chosen, the significant data to be taken into account for computing the interference parameter associated with a mobile transceiver located within a given cell will be data pertaining to said given cell, data pertaining to cells listed in the neighbour list of said given cell, i.e. of the first neighbourship degree, cells listed in each neighbour list of each cell listed in the neighbour list of said given cell, i.e. of the second neighbourship degree, and so on to the Nth degree.

The neighbour list of a given cell may be generated by taking into account only geographical features of the best server map, i.e. by selecting only those cells which have a coverage area which is adjacent to that of the given cell. In this example, the neighbour list of the cell including the base station BS4 would thus comprise the cells which include radio base stations BS2, BS3, BS5, BS6, BS7 and BS13, the latter being included in this neighbour cell list because of the AC43 pocket. According to such a scheme, the neighbour list of the cell including the base station BS2 would thus comprise the cells which include radio base stations BS1, BS3, BS4, BS6, BS8, and BS9, so that if a neighbourship degree N=2 was selected for performing an identifying step in order to compute an interference parameter relating to a mobile transceiver located within the coverage area associated with radio base station BS4, data pertaining to cells including radio base stations BS1, BS8, and BS9 would be selected in addition to data pertaining to cells including radio base stations BS2, BS3, BS5, BS6, BS7 and BS13, as would be data pertaining to cells listed in the neighbour cells including each of the other radio base stations BS3, BS5, BS6, BS7 and BS13.

In this example where N=2, data pertaining to cells including radio base stations BS1, BS2, BS3, BS4, BS5, BS6, BS7, BS8, BS9, BS10, BS11, BS12, BS13, BS15, and BS16 will be selected for executing the computing step. Data pertaining to the cell including radio base station BS14 will not be selected, since this cell is a neighbour of the cell including radio base station BS4 only to the third degree, as being a neighbour to the first degree of the cells including radio base stations BS1, BS8 and BS15, themselves being neighbours to the second degree of the cell including radio base station BS4.

The neighbour list of a given cell may be also generated on the basis of the monitored set corresponding to said given cell.

CLAIMS

1) A method of simulating operating conditions of a telecommunication system including a plurality of radio base stations and another plurality of mobile transceivers, said method including a computing step for computing at least one value of at least one interference parameter related to one of said mobile transceivers, which interference parameter is indicative of an amount of interference affecting a communication between said mobile transceiver and an associated radio base station,

said method including:

. an identification step for identifying radio base stations and mobile transceivers which will generate significant amounts of interference affecting said communication, and

. a selection step for selecting data related only to those radio base stations and mobile transceivers identified during the identification step for execution of the computing step.

2) A method as claimed in claim 1, further including a list generation step for creating, for each given cell including a radio base station, a neighbour list containing identities of neighbour cells including radio base stations with which a mobile transceiver included in said given cell could potentially establish a communication, the identification step then essentially consisting in identifying neighbour cells of a cell including the mobile transceiver to which the interference parameter to be computed relates.

3) A method as claimed in claim 2, in which the identification step essentially consists in identifying cells which are neighbours to a predermined degree of the cell including the mobile transceiver to which the interference parameter to be computed relates.

4) A simulation device for simulating operating conditions of a telecommunication system including a plurality of radio base stations and another plurality of mobile transceivers, said device including computing means for computing at least one value of an interference parameter related to at least one of said

mobile transceivers, which interference parameter is indicative of an amount of interference affecting a communication between said mobile transceiver and an associated radio base station,

said device further including:

. identification means for identifying those radio base stations and mobile transceivers which will generate significant amounts of interference affecting said communication, and

. selection means for selecting data related only to those radio base stations and mobile transceivers identified by the identification means for transmission to the computing means.

5) A simulation device as claimed in claim 4, further including list generation means for creating, for each given cell including a radio base station, a neighbour list containing identities of neighbour cells including radio base stations with which a mobile transceiver included in said given cell could potentially establish a communication, the identification means then being essentially intended to identify neighbour cells of a cell including the mobile transceiver to which the interference parameter to be computed relates.

6) A simulation device as claimed in claim 5, in which the identification means are essentially intended to identify cells which are neighbours to a predermined degree of the cell including the mobile transceiver to which the interference parameter to be computed relates.

7) A simulation device as claimed in one of claims 4 to 8, comprising :

. a simulation module intended to simulate movements and ongoing communications of said mobile transceivers according to a given set of operating conditions of the radio base stations and transceivers, said simulation module including the computing means, the identification and the selection means, and

. a management module intended to update said given set of operating conditions of the radio base stations and transceivers with respect to said simulated movements and ongoing communications of said mobile transceivers, said management module including the list generation means,

in which the simulation and management modules operate asynchronously with respect to each other.

8) The use of a simulation device as claimed in claim 7 for testing a radio network controlling unit intended to manage ongoing communications between mobile transceivers and radio base stations in an actual deployment of a telecommunication system, said use essentially consisting in substituting said radio network controlling unit for the management module.

9) The use of a simulation device as claimed in claim 7 for testing a radio base station intended to be included in the simulated telecommunication system when actually deployed, said use essentially consisting in connecting said radio base station to the simulation module.

ABSTRACT

"Method of simulating operating conditions of a telecommunication system requiring a limited amount of computing power"

The invention relates to a method of simulating operating conditions of a telecommunication system, said method including a computing step CMP(IPi,Dj) for computing at least one value of an interference parameter IPi related to at least one mobile transceiver, which interference parameter is indicative of an amount of interference affecting a communication between said mobile transceiver and an associated radio base station.

The method according to the invention includes:

. an identification step IDS(SCj) for identifying radio base stations and mobile transceivers which will generate significant amounts of interference affecting said communication, and

. a selection step SEL(Dj) for selecting data Dj related only to those radio base stations and mobile transceivers identified during the identification step IDS(SCj) for execution of the computing step CMP(IPi,Dj).

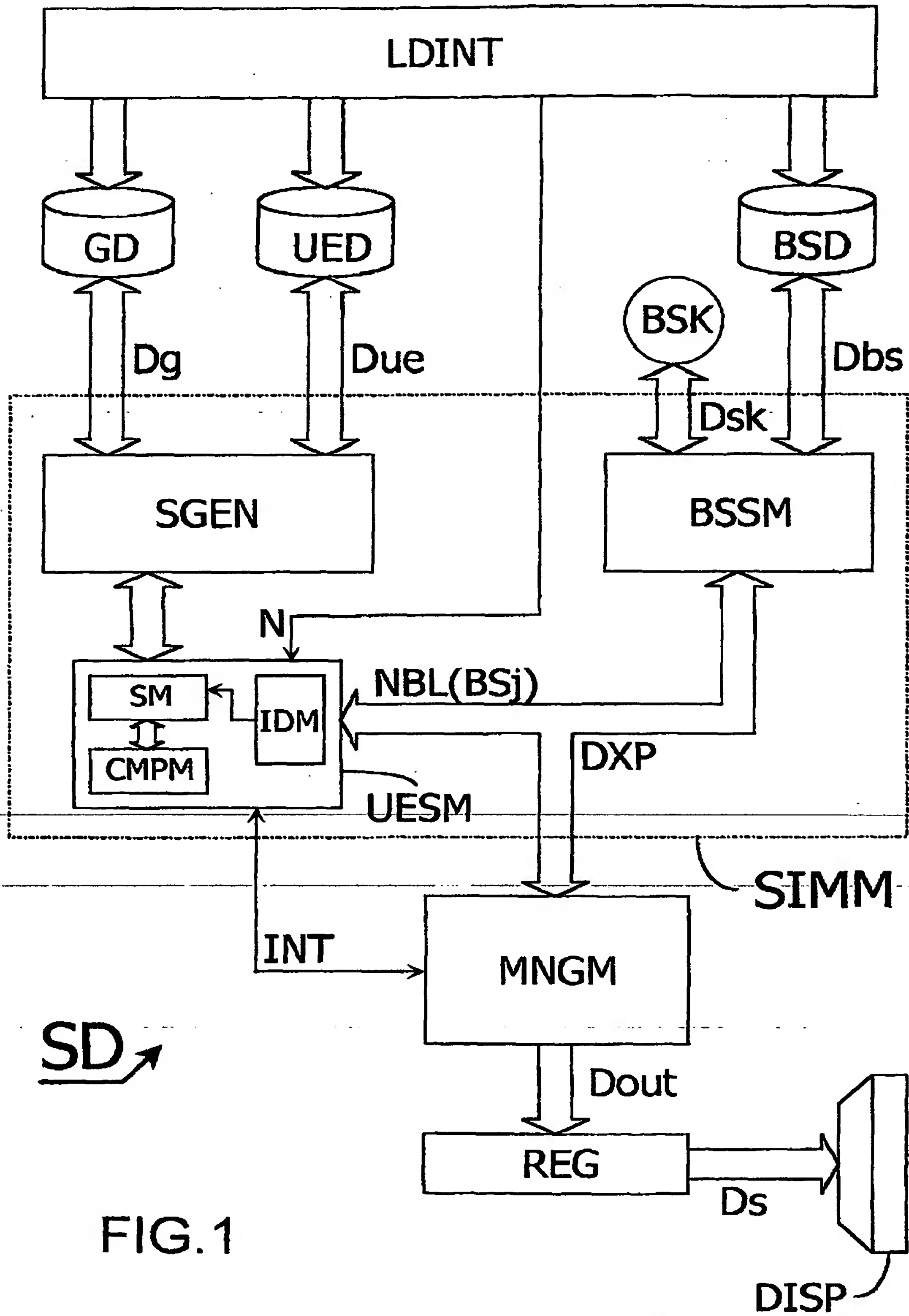
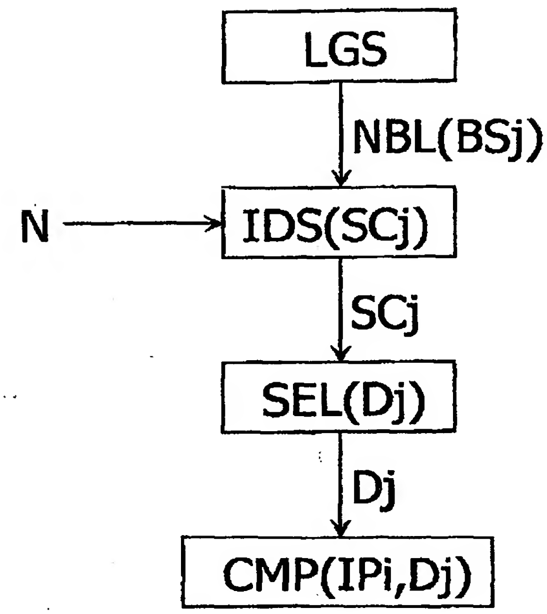

LDINT
GD
UED
BSD
BSK
Dg
Due
Dbs
Dsk
SGEN
BSSM
N
SM
IDM
CMPM
NBL(BSj)
DXP
UESM
SIMM
INT
MNGM
SD
Dout
REG
Ds
DISP

FIG.1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NBL(BSj)
N
IDS(SCj)
SCj
SEL(Dj)
Dj
CMP(IPi,Dj)

FIG.2

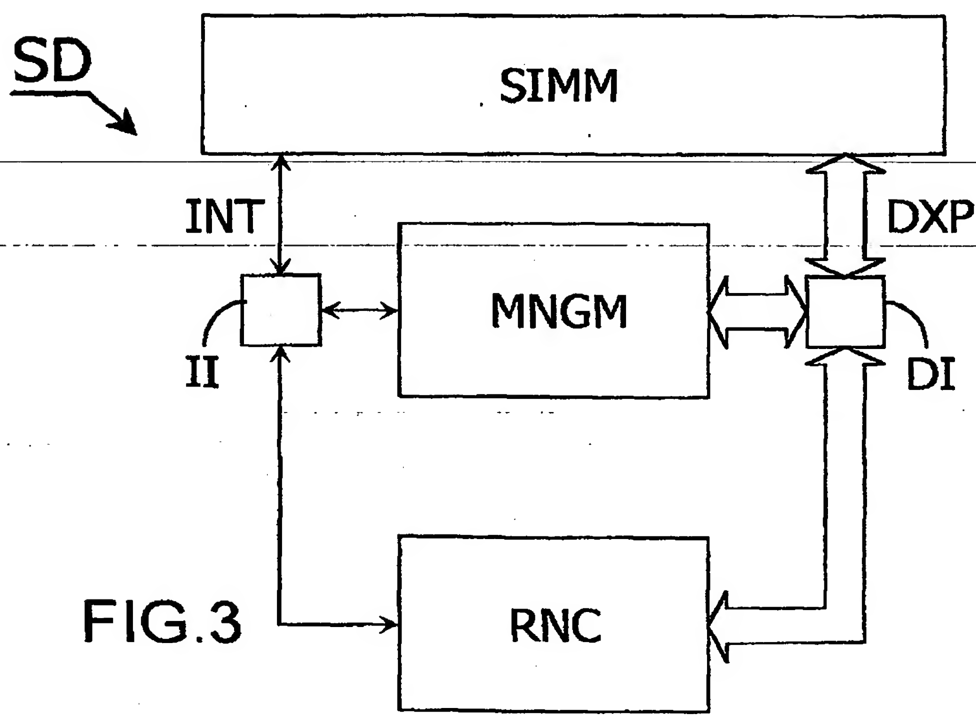
SD
SIMM
INT
DXP
MNGM
II
DI
RNC

FIG.3

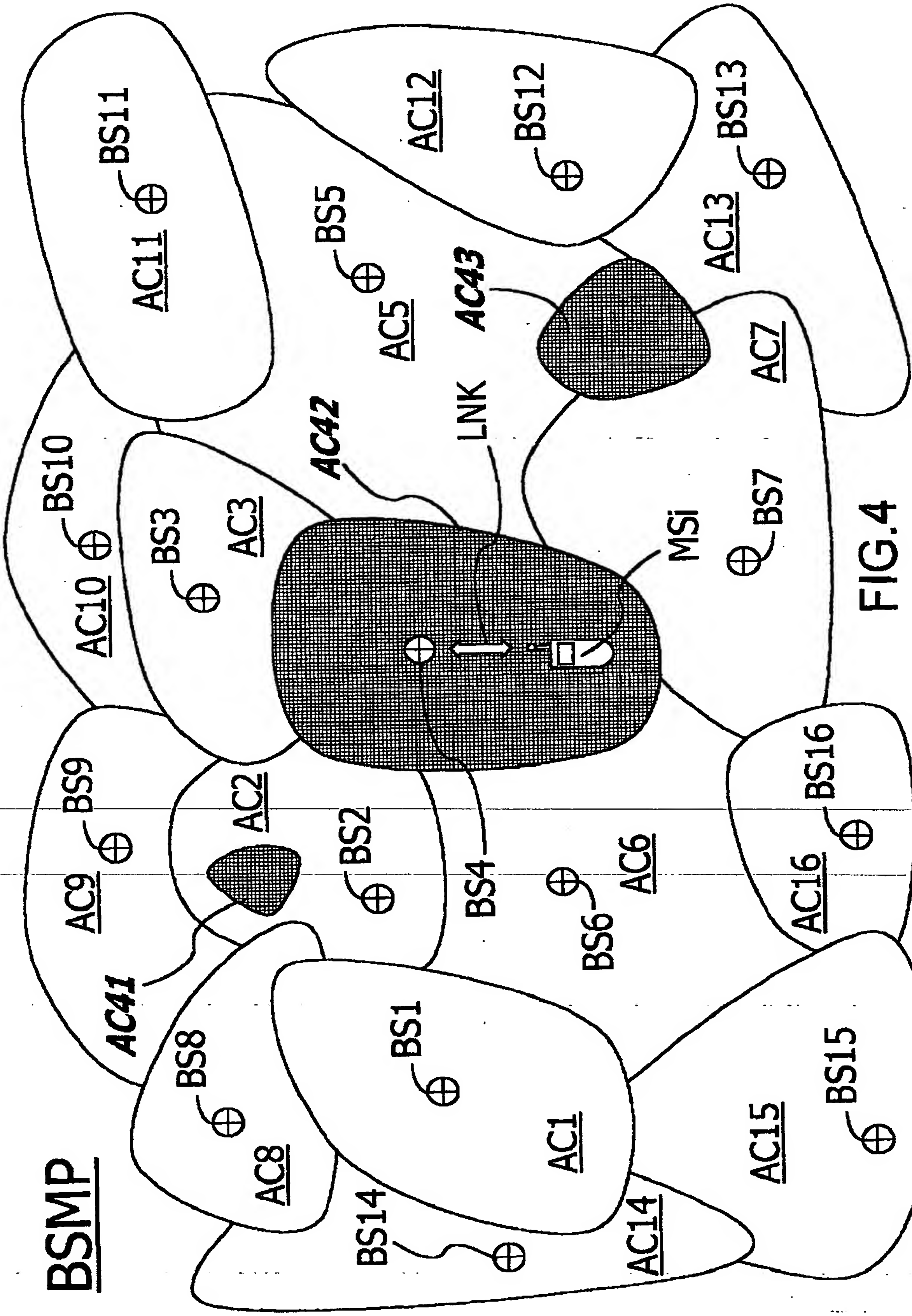
BSMP
AC11
BS11
AC12
BS12
AC13
BS13
BS5
AC5
AC43
AC7
AC42
LNK
BS10
AC10
BS3
AC3
MSi
BS7
BS9
AC9
AC2
BS2
AC41
BS4
BS6
AC6
BS16
AC16
BS8
AC8
BS1
AC1
BS14
AC14
AC15
BS15

FIG.4